Pre-synopsis entitled

‘Exploration of Potassium Solubilizing Microorganisms (KSM) for Growth Promotion of Groundnut (*Arachis hypogea* L.)’

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Introduction:

Groundnut *(Arachis hypogea L.)* is an important oil seed crop of tropical and subtropical region of the world. According to the state's Agriculture Ministry, Maharashtra is the 6th largest groundnut-producing state in the country. However, its total contribution in the total production of the nut is just 5% (1,93,000 MT). In 2019, over 1,87,500 hectares of land in the state was used for groundnut production. The average production in Maharashtra is one thousand kg per hectare (https://www.newsclick.in/maharashtra-low-groundnut-production-due-unseasonal-rain-hurts-farmers-and-dependent-industries). It contains high quality edible oil (48 percent), easily digestible protein (26 percent) therefore considered as 'king of oilseed' among the oilseed crops and botanically classified in family *Fabaceae*, (Bhadiyatar *et al*.,2022). Groundnut provides an inexpensive source of quality dietary protein and oil to millions of people in world especially in developing countries. Also it is a source of supplement the dietary requirements of humans and farm animals (Asibuo *et al*.,2008). Groundnut are a great blend of healthy fats, protein and fibres that curbs your appetite, lower the risk of heart disease and regulates blood glucose level, it prevents cancer, child's boost memory, control diabetes.

Due to deficiency of potassium in groundnut, it can be invited different diseases like, potassium deficit plants exhibit chlorosis (loss of bottom leaves) and progressing up the plant. In severe cases, the leaves appear dry and scorched ,lack of potassium causes stunted plants with small branches and little vigor (http://agropedia.iitk.ac.in/content/potassium-deficiency-symptoms-groundnut). Farmers have become increasingly dependent on chemical sources of fertilizers (Glick, 2012). While the chemical fertilizers helped plant grow, they did not improve the properties of soil. It is well known that the constant use of chemical fertilizers, mainly phosphorous, nitrogenous, and potassic fertilizers have harmful effects on the environment (Adesemoye and Kloepper, 2009).

After nitrogen (N) and phosphorous, potassium (K) is the most important plant nutrient that has a key role in the growth, metabolism, and development of plants. In addition to increasing plant resistance to diseases, pest, and abiotic stresses, k is required to activate over 80 different enzymes responsible for plant and animal processes e.g. such as energy metabolism, starch synthesis, nitrate reduction, photosynthesis and sugar degradation (Almeida *et al.,*2015; Cecilio Filho *et al.,* 2015; Gallegos-Cedillo *et al.,* 2016; Hussain *et al.,* 2016, White and Karley, 2010;Yang *et al.,*2015). K is the seventh most abundant element in earth's crust. Total K content in soils ranges between 0.04 and 3% K. Although k is present as an abundant element in soil, only 1 to 2% of this element is available to plants (Sparks and Huang,1985). The major amounts of K in the soil is present as fixed form (non -available to plant) due to imbalanced fertilizer utilization, great increase of crop yield (depleting soil solution K), and the depletion of K in the soil system. As a result, K deficiency has been reported in most of the crop plants (Meena *et al.,* 2014; Xiao *et al.,* 2017),

To find out easy solution for making potassium available to the plant in usable form (Soluble Form), We will isolate and identify potassium solubilizing microorganism, inoculate these KSM in groundnut crop field. This inoculated KSM as biofertilizer will multiply in the soil and have potential to convert insoluble (fixed) K form into soluble k form .

Potassium solubilizing microorganisms are eco- friendly with environment , it can enhance plant productivity, improve soil texture and quality, moreover the use of KSM may be one such strategies that can improve agricultural productivity on sustained basis.

Review of literature :

Not much research work has been carried out on Potassium solubilizing microorganisms in the past. But in recent years, research work has been focused on PGPRs including Potassium Solubilizing Microorganisms. Few of these research work has been reported here, (Ahmad *et al*., 2016) showed total pool of soil k is extremely complex, and this can be solubilized into plant available k by k-Solubilizing microorganism through their mechanism (Singh *et al.,* 2010; Basak and Biswas, 2012). Production of different types of organic acids is the primary mechanism, which is used by silicate solubilizing bacteria for release of k making it bioavailable by solubilization and mobilization of minerals. This shows the effectiveness of potassium solubilizing bacteria for promoting plant growth and development, this growth improvement was observed by several microorganisms on a variety of crops.

Also, in 2016 Verma *et al*., have isolated and purified potassium solubilizing microorganism by using mica (insoluble potassium) from the soil sample of different regions of India basically U.P and M.P on Aleksandrow's agar media. Out of 14 isolated bacterial isolates, 7 bacterial isolates showed highest D/d ratio. Maximum k solubilization was achieved in KCL and K_2SO_4. The isolated bacterial strain was identified as *Micrococcus warians* and *Corynebacterium kutscheri*. KSB treated groundnut plant showed maximum pods of 16 and seeds 72 per plant as compared to control having pods7 and 21 seeds.

Etesami *et al*., (2017) have presented an overview of current trends and challenges on KSB, mechanisms and their role in plant growth promotion and eventually gives some perspectives for research on k in agriculture Application of chemical fertilizers has a considerably negative impact on environmental sustainability It is known that can solubilize k– bearing mineral and convert the insoluble k to soluble form of k available to plant uptake. Many bacteria such as *Acidothiobacillus ferrooxidans*, *Paenibacillus spp*, *Bacillus mucilaginosus*, *B. edaphics* and *B. circulans* have capacity to solubilize k minerals (E.g. biotite, feldspar illite ,muscovite , orthoclase and mica). KSB are usually present in all soils. Although their number, diversity, and ability for k solubilization vary depending upon the soil and climatic condition. KSB can dissolve silicates minerals and release k through the production of organic and inorganic acid, acidolysis polysaccharides, complex lysis, chelation, and exchange reaction. Hence production and management of biological fertilizers containing KSB can be effective alternative to chemical fertilizers.

Chaudhary *et al.,* (2019) have been presented that almost all the growth and yield parameters of groundnut viz. plant height at harvest (58.3 cm), number of pod per plant (29.3), pod yield (2872 kg/ ha) and haulm yield (4274 kg/ha) were recorded significantly higher with application of RDF +NPK consortium (T9) over the rest of the treatment with regards to oil content of groundnut application of RDF+NPK consortium (T9) gave significant impact on increment of oil content in kernel(48.35%). In their study have been presented the potassium treatment was impacting on the growth, yield, oil content and quality of groundnut, when it grown in loamy sand soil. This review suggests that lot of research work has been going on Potassium Solubilizing Microorganism, their effect on growth of plants as well as their usefulness for biocontrol of plant pathogens also.

Similarly, involvement of fungi in solubilising the Potassium and providing it to promote the growth of plants have been reported by various researchers. Prajapati *et al.,* (2012) isolated 4 fungi on Aleksandrov agar supplemented with 0.5% potassium aluminium silicate, which gave the high ratio of clear zone. Two fungal strains out of 4 strains, i.e., KF1 and KF2 which solubilized potassium aluminium silicate and showed the highest available potassium in liquid medium. One of the fungal strains is fast growing black colonies on potato dextrose agar with distinctive conidial heads characterized as *Aspergillus niger*. While another shows green powdery colonies on potato dextrose agar and characterized as *Aspergillus terreus*. KF 1 shows highest potassium solubilisation and acid production by utilizing feldspar and potassium aluminium silicate as an insoluble source of potassium.

Kasana *et al.,* (2017) isolated five fungi from arid soil of Jodhpur. Out of these five fungi, two fungi identified as *Fomitopsis meliae* RCKF7 and *Aspergillus tubingensis* RCKF5 showed highest solubilization of potassium. On further screening of the more potent strain RCKF7, showed its ability to grow and solubilize potassium over a wide range of temperature (20 to 38 oC) and pH (5.0 to 10.0). The maximum potassium solubilization index was observed at 28 ^{o}C and pH 6.0. Capability of RCKF7 to solubilize phosphorus also rendered it an additional advantage.

Aims and Objectives:

Considering the significance of groundnut crop and role of potassium solubilizing microorganisms (KSM) on productivity, following objectives are set to explore the problem and study it in detail to develop biofertilizer for promotion of productivity of groundnut crop in a cost-effective and eco- friendly strategy.

- Isolation of Potassium Solubilizing Microorganisms (KSM) from rhizospheric soils.
- Identification of most efficient Potassium Solubilizing Microorganisms (KSM)
- Finding the mechanism of Potassium Solubilization.
- Preparation of carrier-based user eco-friendly formulation of efficient Potassium Solubilizing Microorganisms.
- Confirmation of groundnut growth promotion by using Potassium Solubilizing Microorganisms by Pot assay method.

Hypotheses:

Proposed hypotheses mainly targeted to develop Potassium biofertilizer using naturally occurring microorganisms. Biofertilizer, a bio-based eco- friendly strategy, offer a practical and economical alternative to chemical fertilizer. Due to this fact about the management of potassium deficiency in groundnut crop, there is requirement to search for eco- friendly, target certain alternative for management of potassium deficiency in groundnut crop field.

Research Methodology:

1. Collection of Soil Sample from Rhizospheric Niches:

Soil sample will be collected from the rhizospheric niches of various crops. For this purpose, the plant will be uprooted carefully, and shoots will be cut off and roots along with rhizosphere soil will be brought to the laboratory in polythene bags. The soil samples will be processed immediately or stored at 4 - 8 $^{\circ}$C for the isolation of potassium solubilizing microorganisms.

2. Isolation of Potassium Solubilizing Microorganism:

Potassium Solubilizing Microorganisms (KSM) will be isolated from the rhizospheric soil samples by dilution plate technique on modified Aleksandrov medium which constitute 0.5% glucose,0.05% MgSo4H2O,0.0006% FeCl3, 0.06 CaCO3, 0.2% CaPO4,0.3% Mica ,3% agar pH 6.5 and phenol red dye as indictor. KSM colonies will be identified on the basis of zone formed around the colonies.

3. Identification of most efficient Potassium Solubilizing Microorganisms:

The most efficient Potassium Solubilizing Microorganisms would be identified by Morphological, Cultural, Biochemical characteristics and, by molecular techniques.

4. Mechanism of Potassium Solubilization:

To find out Potassium Solubilization mechanisms, the cultures would be tested for production of different organic acids (Prajapati *et al.,*2012; Ahmad *et al.,* 2016 ; Sattar *et al.,*2019; Hamid and Bashir, 2019). Quantitative estimation of K solubilizing will be performed by flame photometry or atomic absorption spectrophotometer where in culture broth will centrifuge and supernatant is used for precipitation of cobalt nitrite (Hu *et al.,* 2006).

5. Preparation of Carrier – based formulation of Potassium Solubilizing Microorganisms:

A carrier-based formulation of Potassium Solubilizing microorganisms prepared by the using the method followed by De Cal *et al.,* (2002).

6. Pot assay for Confirmation of Groundnut Growth Promotion by using KSM:

By using pot assay, the growth promotion ability of KSM would be confirmed by following the method of Rakh R. R. (2010).

Importance of study:

International Status :

Oilseed crops have been grown all over the world and are considered as an important crop due to their economic value. Recently oil seed have attracted more attention due to an increasing demand for healthy vegetable oils and medicinal uses. To enhance groundnut production, we must search for effective substitute to chemically fertilizers by using naturally occurring microorganism like potassium solubilizing microorganisms, PGPR, Phosphate Solubilizing Microorganism etc that can be grown and multiply in laboratories and which can serve as effective efficient economical way for, better production of crops.

Zhang and Kong, (2014) reported enhancement of tobacco plant growth by the application of *Enterobacter aerogenes, Pantoea agglomerans, Agrobacterium tumefaciens, Microbacterium foliorum, Myroides odoratim*imus, and *Burkholderia cepacia*. After being treated with the four KSB strains, plant dry weight and uptake of both K and nitrogen (N) by tobacco seedlings increased significantly.

Siddiqui *et al.,* (2021) isolated 50 rhizobacterial strains and 50 rhizobial strains using Aleksandrov's medium. In this study, the strains SKB3 (rhizosphere) and JKR7 (rhizobia) were the most efficient K-solubilizers. Additionally, they possessed diverse plant growth promoting traits such as root colonization, the synthesis of siderophores, exopolysaccharides, chitinase activity, indole-acetic acid production and 1-aminocyclopropane-1-carboxylic acid deaminase activity. Overall, these results suggest that the application of bacterial K-solubilizers could be employed as a useful K-supplement in K-limited agroecosystems.

No research work on growth promotion groundnut by using Potassium Solubilizing Microorganisms have been done.

National Status:

At national level not much research work has been done on growth promotion of groundnut by using Potassium Solubilizing Microorganisms but use of KSM for growth promotion of different plant have reported. Some of them reported here.

In a report, a promising K solubilizing bacterium, *Paenibacillus glucanolyticus* obtained from the rhizospheric region of blackpepper was significantly improved plant growth and K uptake (Sangeeth *et al.,* 2012). The use of K solubilizing microbes as plant probiotics is a sustainable and alternative way to achieve a positive impact on crop quality, growth and yield, and help in reduces the fertilizer input. Several K-solubilizing microorganisms have been reported such as *Bacillus, Agrobacterium, Burkholderia, Enterobacter, Microbacterium foliorum, Myroides, Pseudomonas, and Pantoea* (Meena *et al.,* 2016).

Kaur *et al.,* (2021) isolated and screened total 125 bacteria for K- solubilization on Aleksandrov agar plates and found that 31 bacterial strains exhibited K-solubilization. The performance of an efficient K-solubilizer was evaluated for plant growth promoting ability in pot assay under in vitro conditions. The strain EU-LWNA-25 positively influenced shoot length, fresh weight, carotenoids, and total sugar content of Barley than the full dose, half dose and control. The strain enhancing physiological and growth parameters was identified by BLASTn analysis as *Pseudomonas gessardii* EU-LWNA-25. K-solubilizing plant growth promoting bacteria could be suitable bioinoculants for Rabi seasonal crops and overcomes the challenges of sustainable agriculture in K-deficient soil.

At national level literature survey revealed that no work has been done on growth promotion of groundnut by using Potassium Solubilizing Microorganisms.

Significance of study:

To enhance the yield of groundnut, both quality & quantity wise and to satisfy the requirement of ever-increasing population, we need to use chemical fertilizers. In these circumstances numerous types of chemical fertilizers are used by farmers to meet plant requirements. However, these fertilizers are costly and long-term use of which result in the increase of cost of inputs, the decrease of agriculture profitability, and many environmental problems due to having heavy metals accumulating in soil and plant system. Chemical fertilizers play crucial role in causing ground water contamination, reduce soil organic matter, destruction of soil biodiversity and negative impact on soil structure.

So, there is need to develop certain eco-friendly fertilizers like KSM. If we add KSM inoculant in groundnut field , it could be an alternative & viable technology to solubilize soil containing insoluble K into soluble form. This application of KSM as biofertilizer not only enhance plant growth and yield but also can lessen use of agrochemicals and support eco-friendly crop production. The changing scenario of agriculture practices and environmental hazards associated with chemical fertilizers demands more significant role of biofertilizers in coming years.

Plan of work (Time schedule of activity):

Sr. No.	Duration (Month)	Work to done
1.	6 months	Collection of Soil Sample from Rhizospheric Niches and Isolation of Potassium Solubilizing Microorganism
2.	12 months	Identification of most efficient Potassium Solubilizing Microorganism (KSM)
3.	18 months	Finding the mechanism of Potassium Solubilization
4.	24 months	Finding the mechanism of Potassium Solubilization
5.	30 months	Preparation of carrier-based user eco-friendly formulation of efficient Potassium Solubilizing Microorganisms
6.	36 months	The Pot assay for confirmation of groundnut growth promotion by using Potassium Solubilizing Microorganisms

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